REMARKS

1. The restriction requirement is respectfully traversed for the following reasons.

i) The composition of claim 9-13, as currently amended, is a solid, i.e. a *cured* rubber composition, not tacky and not useful as a hot pressure sensitive adhesive.

ii) The composition is not a true intermediate of the final device, because the composition does not lose its identity during the assembly process but remains a cured rubber composition. See MPEP § 806.05(i) where it says "Typically, the intermediate loses its identity in the final product..."

iii) Applicant respectfully suggests the articles claimed are best considered under MPEP § 806.05(c) as a "subcombination essential to combination." There is no evidence that the final products claimed are separately patentable without the details of the rubber composition claimed. The rubber is an essential element in the final product and is primarily used for its vibration damping characteristic, i.e., for use in the devices of claims 1-8 or 14-15.

iii) The articles of claims 14-15 also rely on the same inventive composition as the devices of claims 1-8 and should be included in Group I to conserve time and resources. None is separately patentable without the details of the composition.

2. Should the restriction requirement be maintained by the Examiner, election of Group I claims 1-8, and withdrawal of Group II claims 9-15, is affirmed by the Applicant.

3. Inventorship is not affected by the election of Group I.

Amendments to the Claims

4. Entry of amendments to claims 1, 7, 8, 9 and 14 is requested. Claim 6 is canceled. Claims 9-15 are withdrawn per the restriction requirement. No new matter is introduced. Antecedent basis for the amended range of viscosity average molecular weight is found in original claim 7 and on page 9 line 5 of the spec. Antecedent basis for the "less than about 1 mole percent isoprene" or "unsaturation" limitation is found in original claim 11 and on page 8 line 7. Antecedent basis for the amendment to claim 7 is found on page 7 line 23. Antecedent basis for the "doubling" of tan δ "at 120°C" in amended claims 9 and 14 is found on page 8 line 30, page 11 line 8, and Table 2.

Antecedent basis for "cured" rubber in claim 9 is found on page 10 lines 21-22 and page 12 line 13.

Claim Rejections – 35 USC § 112

5. Applicant acknowledges but respectfully traverses the Examiners rejection of claims 1, 7, and 8 for indefiniteness. "Viscosity average molecular weight" ("VAMW") is a term of art well known in the field of polymer science and more precise than the term "average molecular weight" which has been recommended by the examiner. As pointed out in the specification at page 10 last paragraph, number average molecular weight and VAMW typically differ by a factor of about 2. Use of "average molecular weight" without specifying whether number, weight, viscosity, or z- average was meant would be indefinite in this context. The applicant chose VAMW because it seemed to be the type of average molecular weight most commonly used in the literature of suppliers of polyisobutylene ("PIB"). For a textbook explanation of viscosity average polymer molecular weight and its general relation to other averages, see e.g. Paul C. Painter and Michael M. Coleman, "*Fundamentals of Polymer Science: An Introductory Text*," Technomic Publishing Co., Lancaster (1994) at pp 352-353 (copy attached).

Claim Rejections – 35 USC § 102/103

6. Rejection of claims 1-8 under 35 USC § 102(b) over Dunlap US 2002/0162627 is acknowledged. Applicant has amended independent claims 1 and 8 to include additional limitations from original claims 7 and 11, which renders the amended claims patentably distinct from Dunlap. Examples E-41 and E-42 of Dunlap, are now outside the scope of the claims because Butyl 268 has too high a mole percent of unsaturation or isoprene (1.6%) and Vistanex MM L-140 has too high a VAMW (1,400,000).

7. Rejection of claims 1-8 under § 103(a) over Dunlap is acknowledged. "All claim limitations must be taught or suggested" to render claims obvious. (MPEP § 2143.03.) The amendment to claims 1 and 8 introduces limitations not found in Dunlap, namely low unsaturation and a certain range of VAMW. Neither is there any suggestion in Dunlap that using any other specific grade, VAMW, VAMW range, or saturation level of substantially isobutylene polymer would be beneficial. Nevertheless, the Applicant obtained surprising, unexpected results and significantly increased damping relative to

the two Dunlap examples (E-41 and E-42) by utilizing other grades of PIB or Butyl with unsaturation below 1 mole percent and VAMW falling in the claimed range.

8. Applicant respectfully submits that the amended independent claims 1 & 8 are now non-obvious and novel over Dunlap, and therefore the dependent claims 2-7 are also. (See MPEP § 2143.03.)

Claim Rejections – 35 USC § 103

9. Applicant acknowledges the rejection of claims 1-7 under 35 USC § 103(a) over Born et al US Patent 6,361,643. The Applicant submits that the current amendments to the claims renders them non-obvious over Born et al. Born et al do not disclose or suggest or render obvious a "*rubber element comprising: 100 parts of ethylene-alpha-olefin elastomer; and 20 to 100 parts of substantially isobutylene or butene polymer having a viscosity average molecular weight in the range from about 50,000 to about 1,250,000 and having less than about 1 mole per cent unsaturation.*" Born et al fall short in several ways: 1) their "liquid rubbers" do not include or fall within Applicant's VAMW range; 2) their "coatings" represent a different field or application from Applicant's cured rubber element; 3) their examples are far from Applicant's composition range; and 4) their disclosure is unconcerned with the amount of unsaturation. Each of these distinctions are discussed at length below. All together, the obviousness rejection should be withdrawn, because the prior art fails to disclose all limitations of the claim, there is no reasonable expectation of success to make the extensive modifications necessary to reach the Applicants claimed invention, and the necessary modifications would render the prior art unsatisfactory for its intended use.

The polymers in Applicant's claimed range of VAMW are not considered to be liquid rubber, but semi-solid or solid rubber. See the attached technical data sheet on ExxonMobil Vistanex PIB where the lowest molecular weight PIBs claimed by the Applicant are described as "clear, very viscous, tacky semi-solids... further subdivided into grades MS (medium soft), MH (medium hard), and H (hard)." Applicant tried liquid rubber, in Comparative Examples 2-5, and found it unsuitable for increasing the damping of solid rubber compositions. Yet, Born et al disclose that liquid rubber is the key to their invention, and they disclose that liquid rubbers typically have molecular weight below 20,000 and preferably from 900 to 10,000 (col 4 23-25), well outside our

claimed range. Born et al do not disclose or suggest use of higher molecular weight grades of PIB or use of non-liquid rubbers in place of their liquid rubber component. Born et al do not disclose or suggest *substitution* of higher VAMW, solid or semi-solid rubber for liquid rubber, but only use solid rubber as an optional *additional* ingredient. Such a modification would render Born's compositions unsuitable for their intended use as coatings. (See e.g. col 4 lines 25-27 and col 5 lines 14 & 62 where the importance of the liquid rubber for coating rheology is mentioned.) "The proposed modification cannot render the prior art unsatisfactory for its intended purpose." MPEP § 2143 V.

The Applicant's invention is a composition of cured rubber. It is not a coating, adhesive or sealing compound, but solid rubber. Though it may be adhered to metal in the final product, it is primarily a rubber element that can be separately molded, handled, assembled and is capable of use as a primary structural element in load-carrying applications such as torsional vibration dampers, belts and hose. (see pages 5-6 of spec). A composition that is primarily a coating, adhesive or sealing compound would be useless for the Applicant's purposes. Thus, one skilled in the art would not expect to apply any of Born's teaching on adhesives/coatings directly, without extensive modification and experimentation, in the entirely different field of cured rubber elements for vibration control devices, belts or hose. Moreover, Born et al do not disclose or suggest use of their compositions for anything other than adhesive/sealing or coating applications. Since the results of such drastic modifications of the prior art would not be predictable, there was "no reasonable expectation of success" and therefore the invention is not obvious over Born et al. MPEP § 2143.02.

Born et al disclose "adhesive/sealing compounds based on liquid rubbers and optionally solid rubbers" (col 3 line 31-32) comprising 5 to 50% liquid rubber and 3 to 10% solid rubber and useful as a coating (Born et al claim 1), i.e. an adhesive based on liquid rubber modified with a minor part of solid rubber. In the examples of Born et al, the most solid rubber used is 10 parts cis-1,4-isoprene to 30 parts liquid rubbers in Example 1. This would correspond to Applicant using 100 parts ethylene-alpha-olefin elastomer and 300 parts of isobutylene polymer, far outside the Applicant's claimed range of 20 to 100 parts. In contrast, Applicant discloses a solid rubber composition having a minor portion of PIB, (which is on Born's list of liquid rubbers, but not actually

present in liquid form in Applicant's composition). Born et al do not disclose or suggest or make obvious a complete role reversal between the liquid rubber and optional solid rubber components of their compositions. Such a reversal in the relative component amounts would be unpredictable and also render Born's compositions unsatisfactory for the intended purpose as coatings.

Finally, Born et al do not disclose or suggest the limitation that the PIB have "*less than about 1 mole per cent unsaturation.*" On the contrary, Born et al use large amounts of polybutadiene, a highly unsaturated polymer, in their Examples. They teach use of "reactive and/or functional groups" (col 5 line 23), and presume that at least some of the liquid rubber used will have "olefinic double bonds" (col 5 lines 29-30). Born et al do not disclose or suggest use of only very low unsaturation (less than 1%) liquid rubber. That would render their compositions uncurable, since the liquid rubber is the major polymer component. On the other hand, the Applicant found that low unsaturation in the PIB additive was necessary for significantly improved damping (page 11 line 16) in a cured rubber composition.

10. Applicant acknowledges the rejection of claim 8 under 35 USC § 103(a) over Andra et al US Patent 4,961,254 in view of Born et al US Patent 6,361,643 or Dunlap. Applicant believes the amended claims render claim 8 non-obvious for the same reasons claims 1-7 are non-obvious over Born. Nowhere in the combination of references is it disclosed or suggested to use in a torsional vibration damper a rubber element comprising "*100 parts of ethylene-alpha-olefin elastomer; and 20 to 100 parts of one or more polymers having a viscosity average molecular weight in the range from about 50,000 to about 1,250,000 selected from the group consisting of polybutylene, polyisobutylene, polybutene, and polyisobutylene-co-isoprene having less than about 1 mole per cent isoprene*" in order to achieve the unexpected result of doubling the damping characteristic of the rubber element (page 2 line 10-11 of spec). "All claim limitations must be taught or suggested" to render claims obvious. MPEP § 2143.03.

Conclusion

11. In light of the amendments and the arguments advanced above, Applicant respectfully requests allowance of all claims.

REFERENCES

12. The Applicant acknowledges that references not relied on may be considered pertinent by the Examiner. The Applicant respectfully requests that the Examiner signify that the references have been considered with her initials on the original IDS with 9 references filed Mar. 31, 2004, as well as the supplemental IDS with 2 references filed Sept. 1, 2005.

FEE STATEMENT

It is believed that no fees are required, but any fees which may be required as a result of the amendments made herein are authorized to be charged to Assignee's deposit account number 07-0475.

Respectfully submitted,

Paul N. Dunlap
Attorney for Applicants
Reg. No. 52,840
Telephone: (303) 744-4156

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attachments

FUNDAMENTALS OF POLYMER SCIENCE

AN INTRODUCTORY TEXT

PAUL C. PAINTER
MICHAEL M. COLEMAN
The Pennsylvania State University

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(see figure 10.16) by measuring the intrinsic viscosity of a number of monodisperse samples (or fractions with narrow molecular weight distributions) of the polymer whose molecular weight has been determined independently from an absolute method such as osmometry or light scattering.

There are numerous values of K and a reported in various texts* for different polymers in different solvents at different temperatures. We caution, however, that many reported values were determined from fractions or whole polymer samples that were not monodisperse and where one particular average molecular weight was employed. One must expect errors when using these values.

The Viscosity Average Molecular Weight

For osmotic pressure and light scattering we saw that there is a clear relationship between experimental measurement and a particular molecular weight average ($\overline{M}_n$ or $\overline{M}_w$). Because viscosity measurements are related to molecular weight by a semi-empirical relationship, we have to consider a new average, the viscosity average, $\overline{M}_v$, for polydisperse polymer samples. This can be obtained by assuming that the solution is so dilute that the specific viscosity is simply the sum of the contributions from all the polymer chains of different length (i.e., they do not interact with one another)

$$\eta_{sp} = \sum_i (\eta_{sp})_i \tag{10.85}$$

where $(\eta_{sp})_i$ is the contribution from all the chains of size i. Substituting:

$$\frac{(\eta_{sp})_i}{c_i} = K M_i^a \tag{10.86}$$

into equation 10.85 we obtain:

$$\eta_{sp} = K \sum_i M_i^a c_i \tag{10.87}$$

Then because the solution is very dilute:

$$[\eta] = \frac{\eta_{sp}}{c} = \frac{K \sum_i M_i^a c_i}{c} \tag{10.88}$$

where:

$$c = \sum_i c_i \tag{10.89}$$

The term c_i/c is simply the weight fraction of i, w_i, in the whole polymer sample and therefore by definition is given by:

$$w_i = \frac{N_i M_i}{\sum_i N_i M_i} \tag{10.90}$$

* See for example, Chapter IV of the *Polymer Handbook*, J. Brandrup and E. H. Immergut, Editors, J. Wiley & Sons, New York, 1975.

Substituting into equation 10.88:

$$[\eta] = \frac{K \sum_i N_i M_i^{(a+1)}}{\sum_i N_i M_i} \tag{10.91}$$

Remember:

$$[\eta] = K M^a$$

so that it makes sense to define a *viscosity-average* molecular weight as:

$$\overline{M}_v = \left[\frac{\sum_i N_i M_i^{(a+1)}}{\sum_i N_i M_i} \right]^{\frac{1}{a}} \tag{10.92}$$

Thus $\overline{M}_v$ is a function of the solvent through the Mark-Houwink parameter a. In a theta-solvent, a = 0.5 and $\overline{M}_v$ lies between $\overline{M}_n$ and $\overline{M}_w$, i.e.:

$$\overline{M}_v = \left[\frac{\sum_i N_i M_i^{1.5}}{\sum_i N_i M_i} \right]_\theta^2 \tag{10.93}$$

For the most probable distribution (see Chapter 4) in a θ-solvent it can be shown that:

$$\overline{M}_n : \overline{M}_v : \overline{M}_w = 1 : 1.67 : 2 \tag{10.94}$$

Finally, in good solvents, a approaches unity and $\overline{M}_v$ approaches $\overline{M}_w$. However, in such solvents the graph of (η_{sp}/c) against c is steeper and often curved so that extrapolation to c = 0 is less reliable. Sometimes you can't win for losing.

E. SIZE EXCLUSION (OR GEL PERMEATION) CHROMATOGRAPHY

Gel permeation chromatography (GPC), a technique which has been fundamental to the development of polymer science, is a traditional analytical method that is now included under the umbrella of the more general classification of separation techniques referred to as size exclusion chromatography (SEC). A schematic diagram of a typical size exclusion chromatograph is shown in figure 10.17.

In SEC, beads which contain pores of varying size and distributions, commonly made from different types of glass (or cross-linked polystyrene in the case of GPC—from which, incidently, the name gel in GPC originates), are packed into a column. This column, or more typically set of columns, is, in effect, a maze for the molecules. A solvent, or mixture of solvents, is pumped

General Information

Description

ExxonMobil Chemical's Vistanex polyisobutylene products are highly paraffinic hydrocarbon polymers, composed of long, straight-chain macromolecules containing only chain-end olefinic bonds. This molecular structure leads to chemical inertness and resistance to chemical or oxidative attack, and solubility in hydrocarbon solvents. The Vistanex PIB products are light-colored, odorless, tasteless and nontoxic.

Vistanex PIBs are classified into two groups according to molecular weight: the LM (low molecular weight) grades are clear, very viscous, tacky semi-solids*; the MM (moderate molecular weight) grades are tough, rubbery solids. The LM products are further subdivided into grades MS (medium soft), MH (medium hard) and H (hard). The MM products are subdivided into four grades according to molecular weights. The grades and some of their properties are shown in Table 1.

Table 1 shows two types of viscosity molecular-weight measurements: Staudinger (M_S) and Viscosity Average Molecular Weight (VAMW) [or Flory molecular weight]. When first introduced, the Vistanex PIB products were classified according to the Staudinger molecular-weight calculation.

The Staudinger molecular weights are very much lower than the actual molecular weights as given by other techniques or the Flory (VAMW) measurement. The VAMW values will be used in this manual. VAMW is calculated from intrinsic viscosity of Vistanex PIB in diisobutylene at 20°C, where

$$\text{Intrinsic Viscosity (dl/g)} = 0.00036\ (\text{VAMW})^{0.64}$$

The VAMW and Staudinger molecular weights, M_S, can be interconverted by the approximate relationship

$$\text{VAMW} = 0.0233\ M_S^{1.56}$$

Vistanex PIB products cover a very wide range of molecular weights. The molecular-weight range available in the Vistanex PIB grades enable their use in a broad variety of applications. For comparison, in between the LM and MM grades are the molecular weights of Exxon Butyl, copolymers of isobutylene with 1-3 mol percent isoprene and VAMWs from about 300,000 to 500,000. For Vistanex PIB MM grades, routine VAMW control and grading is done with a Rubber-Processing Analyzer (RPA) method which has been calibrated to correlate with VAMW via intrinsic viscosity.

FDA Regulations

The use of Vistanex PIB in food applications is controlled by the Food and Drug Administration (FDA) in the Code of Federal Regulations (21 CFR, Part 170 – Food Additives). Two types of food additives are covered: materials added directly to food (Subpart D), and

* The ExxonMobil Chemical publication *"An Introduction to Vistanex PIB LM Low Molecular Weight Polyisobutylene"* discusses the LM products in detail.

Table 1
Typical Inspections of Vistanex PIB

All Grades		Grade	Viscosity Molecular Weight (M_S) (Staudinger)	Viscosity Average Molecular Weight (VAMW) (Flory)	Intrinsic Viscosity* (dl/g)
Specific gravity	0.92				
Color	White to pale yellow				
LM Grades Only	Maximum	LM-MS	10,400-10,900	43,000-46,000	—
Volatiles, weight %	3.0	LM-MH	11,600-12,300	51,000-56,000	—
		LM-H	12,600-14,000	58,000-68,000	—
MM Grades Only	Maximum	MM L-80	64,000-81,000	750,000-1,050,000	2.07-2.57
Ash, weight %	0.3	MM L-100	81,000-99,000	1,060,000-1,440,000	2.58-3.15
Volatiles, weight %	0.3	MM L-120	99,000-117,000	1,450,000-1,870,000	3.16-3.72
Stabilizer, weight %	0.10	MM L-140	117,000-135,000	1,880,000-2,350,000	3.73-4.30

* In diisobutylene at 20°C

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